Between Human and Veterinary Medicine: The History of Animals and Surgery

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As surgical subjects, animals were affected by, and contributed to many of the developments described in this handbook on the history of surgery. Yet as its chapters illustrate, when medical historians refer to surgery, they generally mean human surgery. Animal surgery is largely neglected. Even historians of animal disease have little to say about the matter.[1] Although occasional glimpses are provided by general veterinary histories and accounts of experimental medicine, there are only a few publications dedicated to its analysis.[2] This situation can be explained partly by the anthropocentric orientation of historical scholarship in general and medical history in particular. Although perspectives are beginning to shift, the roles of animals as products and shapers of history and society are still insufficiently acknowledged. Another factor is the diffuse and multi-faceted nature of animal surgery, which poses methodological challenges above and beyond those faced by historians of human surgery. Whereas human surgery was generally confined to clinical contexts and performed by dedicated practitioners whose actions were recognised at the time to be 'surgical' in nature, animal surgery was a more amorphous practice encompassing multiple species, whose diverse anatomies, physiologies, lifestyles, behaviours, disease tendencies and relationships with humans generated various rationales for surgery, and posed technical and ethical challenges to it.

This chapter aims to facilitate future scholarship on the subject by describing some of the main features and cross-cutting themes of the history of animal surgery. It also suggests ways of approaching its analysis, and future directions for research. It revolves around the two key contexts in which animals occurred in surgery. In clinical settings, they performed the roles of patients. This involved a three-way relationship between the animal, their owner/keeper, and the surgeon. In experimental settings, animals were manipulated surgically for scientific purposes. Here, the scientist-surgeon was also the *de facto* owner, although, as we will see in more detail, certain groups

of the public sometimes tried to intervene in their relationships with animals. When investigating the history of animal surgery, it is necessary to consider both contexts, and the historically contingent relationships between them. However, locating animal surgery in the historical sources can be tricky due to the lack of a sharp distinction between this activity and other medical and scientific interventions performed on animals.

The scientists who experimented on animals, and the healers who populated the veterinary marketplace both before and after the late eighteenth century creation of a veterinary profession, practiced both medicine and surgery. Except where human surgeons were involved, those performing surgery on experimental animals were not referred to as surgeons. Veterinary surgeons did not confine themselves to surgery, and the terms veterinary medicine and veterinary surgery were used non-specifically and interchangeably. Prior to the nineteenth century, surgical interventions on experimental animals can be identified because they were referred to as 'vivisection.' Subsequently, however, the meaning of this term expanded. Like 'experiment' and 'procedure', it became a generic label for all kinds of animal manipulations.[3] Historians of experimental medicine have not helped matters by referring to all experimental animals as 'models.' Rarely used before the mid-twentieth century, this term conflates the diverse interventions performed on experimental animals, and their varying objectives.[4]

The blurred boundaries of animal surgery force historians to impose their own definitions on the field. For the purpose of this chapter, 'animals' will be defined – as they usually were by historical actors – as non-human vertebrates.[5] 'Experimental animals' were those subjected to manipulations for the purpose of advancing science and medicine. When considering the surgery performed upon them, this chapter adopts a more inclusive approach than Schlich, Mykhalovskiy and Rock, who restricted their analysis to the removal of animal organs for use in humans, and animal-based research into human surgical procedures. They selected these interventions because of their intended surgical benefits to humans.[6] In shifting the focus from human beneficiaries to

animal subjects, this chapter identifies a much wider range of interventions, many of which were not intended to advance surgery, but rather to investigate and demonstrate the physiological functioning of the body.

Schlich's definition of surgery as 'the controlled intervention into the structure of a living body in order to repair that structure or to restore a bodily function to a healthy condition'[7] is only partially applicable here, for while animal surgery involved controlled interventions into bodily structures, it had diverse objectives. As patients, animals could be subjected to non-therapeutic interventions such as castration. In experimental settings the goal of animal surgery was not to repair the body (unless it was damaged experimentally for that purpose), but to disrupt it. Experimenters often justified this disruption by reference to future benefits for human and animal patients. Such claims were underpinned by a belief in their shared physicality, which meant that findings could be extrapolated between species.[8] However they were frequently contested. Consequently, although (as in humans) surgery required greater justification than other therapies owing to its violation of the body, the experimental surgical violation of animal bodies often required very special justification.[9]

The following survey adopts an integrated, largely chronological approach to animals as surgical patients and experimental material. It focusses particularly on the modern era, and concludes with some suggested directions for future research. It draws out two key themes which have emerged in recent dedicated histories of animal surgery.[10] The first theme is the historical co-constitution of animal surgery and human-animal relations. How humans valued and related to particular animals shaped their demands for particular surgical interventions, which in turn shaped the activities and expertise of surgeons in ways that validated human-animal relations. The second theme deals with the historical connections between animal surgery and human surgery as two modes of surgical practice. Animal patients were sometimes subjected to interventions already performed on human patients, and, like human patients, they benefitted from interventions

performed on experimental animals. Human surgeons sometimes operated on animals in addition to or even instead of humans while animal healers occasionally moved in the opposite direction. Exploring the nature and extent of these connections reveals perceived similarities and differences in the moral status, physical nature and cultural valuation of surgical subjects. In highlighting the multi-species dimensions of surgery, this chapter also demonstrates the need to transcend professional and species boundaries when writing its history.

Pre-modern animal surgery

Reports of surgery upon experimental animals date back to antiquity. Prominent examples include a Hippocratic text on the heart, and works by the famous Greek doctor, Galen, working in second-century Rome. They vivisected animals to discover or demonstrate the functions of certain anatomical structures.[11] Evidence of animals as surgical patients is even older. Archaeological findings reveal occasional attempts by humans to heal the fractures of domestic animals,[12] while tomb paintings in pre-Pharonic Egypt depict cows whose horns were surgically manipulated for religious reasons, to form cyclical representations of earth and heaven.[13] The *Hippiatrica* – a collection of manuscripts that formed the standard Byzantine text on horse health and healing – borrowed from human medicine in providing instructions for the surgical treatments of wounds and fractures.[14] One author, Pelagonius, discussed the use of cautery, bloodletting, castration and surgical debridement, mainly in horses but also in sheep and cows. He also referred to the various individuals who applied these methods, ranging from shepherds to specialist animal healers.[15]

Housni Alkhateeb Shehada's analysis of Arabic manuscripts from the Mamluk period offers rich insights into the surgery that high-status 'veterinarians' performed on valuable horses, hawks and falcons at the Mamluk courts. Describing the cauterisation, cleaning and suturing of wounds, the surgical treatment of hooves, bleeding, castration, gynaecological surgery, the removal of skin growths, and care of fractures (including the use of resin to repair hawks' broken talons), he

concludes that techniques had advanced beyond those of the classical period, and were superior even to those used in human surgery at the time.[16]

Louise Curth offers some insights into animal surgery in Early Modern England. This was usually performed on useful animals like horses and livestock by healers ranging from elite farriers to cow-leeches and laypeople. Practices changed little over the period, and often resembled those of human surgery, as in the management of wounds, bladder stones, skin diseases, limb amputations, fractures, the use of cautery and bleeding. However some operations were specific to animals, like castration to improve the performance and manageability of horses and livestock,[17] and - as revealed by archaeological evidence - the tail-docking of female lambs to protect them from maggots.[18]

The Renaissance witnessed a resurgence of surgical experiments on animals.[19] Revisionist analysis is beginning to unpack their different practices and epistemic motivations. These ranged from Vesalius's revival of Galen's method of demonstrating human bodily functions on animals, to experiments aimed at discovering new knowledge about the difference between life and death, the heat and fluids of the heart, and the motion of the heart and lungs, as performed by Colombo, Fabricius, Harvey and many others. Pigs and dogs were the preferred subjects, although Harvey also vivisected many cold-blooded creatures.[20] In Early Modern Europe, vivisection formed part of the public culture of anatomy, as illustrated by Alexander Monro primus, professor of anatomy in Edinburgh, 1722-64, who vivisected dogs to illustrate the functioning of human anatomical structures, as well as for the moral edification of his students.[21]

The validity of these practices was often subject to debate. Some experimenters were uneasy about the suffering they caused, and queried the Cartesian belief that interventions were morally justified because animals were inferior 'beast-machines' that lacked a rational, immaterial soul. The presumed physical similarity of humans and animals was also questioned: were general conclusions possible from studies of particular animals, and could knowledge drawn from suffering

animals shed light on normal humans?[22] These issues arose especially when the subjects studied were the mind, brain and nerves - as for Swiss physiologist Albrecht von Haller (1708-1777) - since the mental faculties of animals were perceived as qualitatively different to those of humans.[23]

Concerning animals as surgical patients, in eighteenth century England, the surgical treatment of elite horse patients was led by medical men, particularly surgeons. Influenced by growing interest in horse racing, selective horse breeding, hunting on horseback and the performance of cavalry horses, they perceived horses as noble and legitimate subjects of their interventions, and worked to refashion farriery from an empirical practice centred on shoeing, into a polite gentlemanly art that incorporated medicine and surgery. They expanded the elite farriers' tool kit to include surgical needles, cauterisers and fleams, and echoed developments within human medicine by founding horse infirmaries for the treatment of horses and tuition of farriers. Whereas country farriers typically combined shoeing and drugging with infrequent bleeding and wound dressing, Edward Snape, owner of a London horse hospital, mostly treated surgical conditions of the skin, lower limb and hoof using bleeding, rowelling (the insertion of a seton under the skin to permit drainage), and firing (whereby tissue on a lame leg was cauterized in the belief that healing made the leg more stable).[24]

At a time when many medical men engaged in the dissection, collection and display of animal bodies, it was not unusual for them to perform animal surgery for the purpose of research. The famous Scottish surgeon John Hunter carried out many physiological experiments and tested human surgical techniques on animals. His many pupils followed suit. These men played a major role in founding and running Britain's first veterinary school in London, which they regarded as an important site for advancing these activities. They modelled it along the lines of human hospitals and the horse infirmaries mentioned above, which were run by elite surgically-trained farriers.[25] The horses admitted to its stables were largely subjected to surgical treatments for lameness. Many of

the early pupils were human surgeons. On qualifying, some were commissioned into the army as 'veterinary surgeons,' a title that was created to distinguish them from human surgeons.[26]

Movements also occurred in the other direction. In 1780s France, the refashioning of the Alfort veterinary school resulted in a new curriculum that included courses in human fracture care and midwifery. However the goal of producing rural veterinarians capable of caring for human as well as animal patients was not fulfilled, as the graduates of this kind of training were resented by surgeons and rejected by the public. In 1788, political changes caused the school to return to its original task of producing horse-oriented practitioners.[27] The French veterinary schools were also important sites for experimental animal surgery. From the 1760s, students used large numbers of worn-out horses to practice their clinical techniques, often several times on the same horse and without using anaesthetics.[28] In addition, experiments were performed frequently on horses to investigate bodily function. Paul Elliott concludes that veterinary schools were therefore important sites for the emergence of experimental physiology in France.[29] For John Lesch, the Paris school of medicine was more important. During the revolution, its reorganised clinical training regime produced a group of men, including the physiologists François Magendie and Claude Bernard, who went on to apply their surgical skills to experimental animals.[30] These developments contributed to a new surgical view of the body as a collection of organs and tissues with specific functions.[31]

Modern animal surgery

During the nineteenth century, the surgery of animal patients continued to be dominated by bleeding, castration, the management of wounds and lameness, as well as assistance with births. Horses remained the main patient base. Despite the coming of steam power and the railways, their numbers expanded throughout the century. In rural districts, cows were also important, and there is some evidence for surgical interventions on dogs.[32] As in earlier centuries, many animals were treated by their owners and carers. Shepherds usually castrated their own lambs, and reportedly

trephined the skulls of sheep to remove tapeworm cysts that pressed on the brain and caused neurological symptoms.[33] In zoos, the keepers took care of minor surgical problems like wounds and abscesses,[34] while in horses, grooms and trainers managed wounds and leg injuries.[35]

The establishment of the veterinary profession added a new group of healers to the marketplace. Although vets were quick to portray their less educated competitors as cruel and ignorant, evidence suggests considerable overlap between their practices.[36] The market was also served by human healers, particularly during the first half of the century. Bonesetters and general practitioners sometimes cared for animals as well as humans. Surgeons carried out various interventions on their own animals and at the request of animal owners – who included their human patients. They treated wounds and fractures in horses, removed tumours from dogs, cataracts from bears, and amputated animal limbs.[37]

Except where pet dogs were concerned, surgical interventions were performed largely for economic reasons, with the goal of quickly restoring animals to function. [38] Zoo animals had to appear before fee-paying members of the public,[39] livestock were expected to grow and reproduce themselves, and horses were required for draft power, for sporting purposes and as cavalry mounts. If return to function seemed unlikely, or if the cost of care threatened to outweigh the animal's value, then slaughter was a viable option and allowed losses to be recouped through sale of meat and hides.[40] Alternatively, successful racehorses could be retained for breeding. This productivist ethos constrained the development and application of intricate surgical procedures. For example, the operation developed to treat the respiratory problem known as 'roaring' found few applications in racehorses because of the lengthy recovery period. Instead, some 'roarers' raced with the aid of tracheotomy tubes.[41]

The economics of surgical care, together with the scientific theory that animals did not feel pain in the same manner as humans, may explain why anaesthesia was not used routinely in animals for decades after its mid-nineteenth century incorporation into human surgery.[42] The adoption of

aseptic surgery followed a similar trajectory.[43] This was despite the experiments conducted on animals with a view to improving surgery in humans.[44] The lack of anaesthesia in animal experiments fuelled protests against this activity, which became particularly vocal in 1870s Britain following the establishment of experimental physiology as a discipline.[45] Protests emerged a little later in the USA, but were less common in France and Germany.[46] They formed part of a wider concern for animal suffering that developed as human relationships with nature were redrawn within urbanising, industrialising societies. The treatment of dogs and horses attracted particular attention owing to their perceived proximity to humans and the concurrent growth of pedigree dog breeding and pet-keeping.[47]

Anti-vivisectionist sentiment in Britain was stimulated by the 1873 publication of the *Handbook for the Physiological Laboratory*. Written by medical scientists, it aimed not to extend knowledge, but to enable beginners to develop skills in vivisection. The descriptions were graphic and there were few references to anaesthesia. Public criticisms of its contents were fired by perceived parallels between dogs as experimental subjects, dogs as pets, and – for the many female anti-vivisectionists – their treatment as patients at the hands of male doctors. Key points of debate were the morality of animal experiments, the accountability of the scientists who performed them, the scientific utility and necessity of this practice, and the suffering it caused. The controversy culminated in legal restrictions to experimenters' activities under the 1876 Cruelty to Animals Act.[48]

These protests focussed particularly on dogs. However, we know from Cheryl Logan's analysis of German experimental physiology that scientists employed diverse species in their experiments (although she does not distinguish medical and surgical procedures).[49] Historians have suggested various reasons for their selection, including convenience (cost and ease of acquisition), practicality (could a particular surgeon perform the desired procedure on a particular species?) and epistemology (could reliable knowledge be produced and generalised to humans and other animals?). The animal's biology, behaviour and psychology had the potential to shape scientific

research, which in turn shaped their bodies and lived experiences.[50] Daniel Todes illustrates this point in his account of the dog experiments performed under the aegis of Russian physiologist Ivan Pavlov. Through a process of trial and error, using facilities, instruments and staff akin to those of human hospitals, Pavlov devised surgical techniques that made dogs' digestive glands accessible for long-term physiological experiments conducted by his scientific assistants. The dogs – which were given names – often failed to perform as expected. Scientists attributed this partly to the failure of surgery, and partly to the dogs' personalities. They responded by taking personalities into account when interpreting experimental results. However, as they did not publicise this approach, it proved difficult for western scientists to replicate their findings.[51]

The problem of replicability – which is a recognised feature of complex experimental systems – dogged other surgical interventions on experimental animals. For example, Jacques Miller, an Australian working in London during the early 1960s, found it difficult to remove the thymus gland of mice in the manner described by a fellow scientist. He subsequently discovered an undocumented 'trick' to the operation. He spread the word informally via conferences and the scientists he trained, but there was never any formal discussion of the technique, which probably varied between laboratories.[52] Journal editors' strategies may have contributed to the problem of replicability, because as Lederer demonstrates for the *Journal of Experimental Medicine* c1921-46, they took steps to abbreviate, omit or reword descriptions of experiments performed on animals to avoid criticisms from anti-vivisectionists.[53]

At the end of the nineteenth century, the values of replicability and standardisation moved from experimental to clinical contexts. Working at the John Hopkins School of Medicine, the famous surgeon William Halsted used dogs to develop and produce evidence in support of new surgical interventions. Adopting a slow, controlled style of operating that aimed to preserve tissues, he sought to perfect techniques in animals for application to humans.[54] Similar values filtered into elite veterinary surgery, as illustrated by the work of Frederick Hobday, future principal to the Royal

Veterinary College, London, who worked to standardise and statistically document operations on dogs and horses, while also emphasising the need for aseptic surgery and good anaesthesia. A strong advocate of comparative medicine, Hobday treated canine surgical patients in the same manner as humans by developing false eyes, teeth and limbs.[55]

Meanwhile, new surgical interventions were performed to extract biological material from experimental animals for the benefit of humans. In the 1910s, the veterinarian attached to the Russian Society for Goat Breeding removed the thyroid glands of goats on the instructions of doctors who believed that milk goats produced after thyroidectomy had medicinal qualities for humans suffering from disease caused by over-active thyroid glands. This was the context in which endocrinology emerged in Russia.[56] In 1920s France, the surgeon Serge Voronoff transplanted primate testicles into men who lacked virility. The procedure was relatively uncontroversial in France, but concerns about cruelty to animal donors and transmission of simian characteristics in humans generated resistance in Britain.[57] Xenotransplantation was investigated further in the 1960s as a means of tackling the shortfall in human organs available for donation. Primates were used initially because of their resemblance to humans, but scientists turned subsequently to pigs, partly in response to resurgent criticisms of animal experiments which were supported by a new philosophy of animal rights.[58] More recently, techniques of kidney transplantation in humans were applied to cats, which performed the dual roles of donor and recipient. The inability of cat donors to grant consent for the operation has prompted considerable reflection on its ethics.[59]

In the twentieth century, domestic animals fell increasingly under the care of veterinarians, who won legal recognition as prime experts in animal health. Other parties were gradually excluded from the performance of surgery on animal patients. While surgery on experimental animals continued to be dominated by scientists – who were often medically trained – vets developed new roles as experts in their management and welfare within the post-WWII field of laboratory animal science. This involved thinking about experimental animals as patients, with the aim of maximising

their health and minimising suffering, both for the benefit of the animal and to turn them into more reliable experimental material.[60] Meanwhile, changes to the domestic animal economy forced veterinarians to adapt their roles and identities as animal healers.[61] Early in the century, the rise of the internal combustion engine caused horses to lose their prime role as animal patients. However a new equine economy emerged, focussed on recreational horses. Dr WJR Fowler, the main equine surgical instructor at Ontario Veterinary College, carved out a unique place in this market, particularly through improving the operation for roaring. By continuing to develop hands-on surgical teaching at the college, and maintaining the horse as the primary animal for student dissection, he equipped his students to take up similar lines of work.[62]

The fashioning of farm animals into veterinary surgical patients was initially impeded by economic depression, which encouraged farmers to view vets as a last resort. It was not until the revival of agricultural fortunes during and after WWII that a viable market for veterinary surgery emerged, prompting research into anaesthesia and surgical techniques.[63] Concurrently, farm animals became subject to non-therapeutic surgical interventions like the de-beaking of poultry, de-horning of cows, and the tail-docking and teeth clipping of piglets. These were performed to reduce the injury risk to other animals, which arose particularly within intensive farming systems.[64] Like so-called 'cosmetic surgery' on pets – tail docking, ear cropping, the removal of cats' vocal cords and (according to some commentators) routine neutering, these methods attracted considerable criticism that resulted in legal restrictions in certain countries.[65]

As the twentieth century progressed, pets became increasingly important veterinary surgical patients. Kept for emotional rather than utilitarian reasons, they were awarded intrinsic value similar to that of family members. This situation gave rise to what Schlünder and Schlich have termed an 'economy of love.' Pet owners demanded improved veterinary care and demonstrated increasing willingness to pay for it.[66] In response, veterinary schools expanded their training in small animal medicine and surgery. By mid-century, the dog had largely replaced the horse as the subject

of student dissection. However, while in the context of inter-war depression, some vets began to view pets as legitimate patients and to campaign against their treatment by laypeople, the traditionally masculine culture of veterinary surgery meant that pets were not popular patients. Women, who were just beginning to join the profession, found themselves channelled into working with them on the grounds that they possessed 'gentle hands' and a 'naturally' caring demeanour.[67] After WWII, pets entered the veterinary mainstream. Practices were reoriented to 'mimic the trends and structures of the increasingly hospital-based and surgically oriented human medicine.' [68] Vets investigated and adopted methods of balanced anaesthesia, turned to X-ray technologies, erected purpose-built hospitals, trained up a new cadre of veterinary nurses, and rapidly expanded their surgical repertoire. They thereby validated the intrinsic value that owners attached to their animals while positioning themselves as defenders of animal experiments on account of the ultimate benefit to animal patients.[69]

Mid-twentieth century fracture care, which is one of the few well-studied topics in the history of animal surgery, offers a fascinating illustration of how the shifting valuation of pets generated higher expectations of surgical care, which resulted in new forms of surgical intervention that circulated between human surgery and different forms of animal surgery. This period saw a movement away from so-called 'conservative treatments' such as plaster casts, splints and bandages, which were applied to both humans and animals with the aim of restoring function. By the 1930s, vets had begun to discuss and test methods of internal fixation that were used in human patients, while during WWII, the US navy purchased an external fixation apparatus devised for use in pets for testing on service men.[70] From the 1950s, new methods of fracture care were pioneered by the Swiss 'AO' association of surgeons. Their scientists used experimental rabbits and dogs to generate basic knowledge about bone growth and to perform clinical research on fracture repair. Although initially intended for use in humans, AO methods were subsequently applied to animal patients (mostly dogs but also racehorses) with the help of human surgeons.[71] It required further research to make these methods effective owing to the different sizes and biodynamics of human

and animal bodies. Scientists initially conducted this research on dogs – who were also the intended patients. Subsequently, they turned to sheep, as despite their dissimilar metabolisms and the difficulties involved fashioning them into surgical subjects, they found it easier to maintain emotional distance from them.[72] Emotion also found its way into clinical contexts, as vets began to realise that X-ray appearances of orthopaedic conditions did not necessarily correlate to owners' descriptions of the animal's clinical state. Despite their preference for 'objective' information, later twentieth century vets began to pay greater heed to animal suffering, as interpreted by owners through the lens of human illness experiences.[73]

Reflection

In summarising existing understandings of the history of animal surgery, this survey has drawn attention to the intersecting histories of animals as surgical patients and experimental surgical subjects. With reference to the shifting valuation of animals, it illuminates why particular species were subjected to particular types of surgery at selected points in time. It also highlights the circulation of ideas, practices and personnel between human and animal surgical domains, and therefore the need for historians of human surgery to incorporate animals within their accounts. Given the generic nature of much existing literature, there is considerable scope for advancing these observations and opening up new perspectives on the history of animal surgery through more focussed analyses. These could address neglected arenas of animal surgery, such as its performance in war and non-western contexts,[74] its comparative and transnational histories, the use of non-therapeutic surgery in animal patients, and the surgery of animals other than dogs and horses. They should also endeavour to push beyond existing descriptions of what types of surgery were performed on what animals, to engage with the more challenging question of *how* surgery was conducted.

One fruitful approach to this problem is to investigate the nature of surgical skill. Schlich argues in reference to human surgery that skill had technical, affective and ethical components. It was embedded in certain 'rules of performance' which were shaped by the surgeon and the context in which they worked.[75] The complexity of animal surgery suggests the existence of multiple rules of performance at any one time. Examining the content of these rules, and how they were fashioned by the two distinctive contexts of animal surgery, its multiple settings (home, stable, farm yard and veterinary clinic), varying objectives, and the physical features and cultural valuations of its animal subjects, would offer important insights into how surgery was practiced. It would also illuminate the characteristics of the 'good surgeon': how did they restrain, operate on, and secure the desired outcomes for their animal subjects, and what traits did they require to win the trust and respect of peers, animal owners and the wider public?

In addition to the surgeon's skill, it is necessary to consider the environment in which they worked, and its human, technological, spatial and animal components. What assistance was provided by grooms, farm labourers, animal owners, veterinary nurses, and laboratory animal technicians? How did they come to participate in animal surgery, what skills did they bring to bear on it, and how did they relate to its human personnel and animal subjects? Surgical technologies also require investigation, ranging from animal anaesthesia and aseptic practices, to the use of gloves, masks, surgical instruments and machines that monitored bodily function. What were their trajectories of development and how did they connect with those of human surgery? In addition, it is important to consider the sites of animal surgery: homes, barns, stables, cages, laboratories, consulting rooms in veterinary clinics, and dedicated operating theatres of varying degrees of sophistication. What are their histories? How were they created and selected, and what was their impact on how and by whom surgery was performed? The roles of animals as shapers and products of this surgical system also requires further attention: in what ways did their physical qualities and moral valuations influence how surgery was performed, and what were their experiences of it?

As in human surgery, it is not easy to investigate surgical practice because it involved many automated and non-verbal ways of working. Sources such as films, articles and texts offer only a partial guide, because the practice of surgery developed with experience.[76] In human surgery, historians have attempted to tackle this difficulty by studying surgical training as a context in which the tacit was made explicit.[77] Analysing the training of animal surgeons promises to be similarly illuminating. Much useful information can be gleaned from autobiographies and oral histories, in which descriptions of surgical training and 'war stories' from practice illuminate otherwise invisible aspects of surgical skill such as its 'hardness.'[78]

For the historian of experimental animal surgery, materials used by historians to reconstruct anti-vivisectionist controversies, such as the 1873 *Handbook of the Physiological Laboratory*, scientists' experimental reports, and first-hand descriptions of vivisection published by its opponents, have the potential to yield additional, novel perspectives on how surgery was practiced. Such sources may help to differentiate between two frequently conflated aspects of experimental surgery: the trial and error development of techniques to turn animal bodies into 'particular kinds of 'machines' designed…to generate particular kinds of facts,'[79] and the application of those techniques in order to gather the desired facts. How techniques were standardised within laboratories and experimental communities is another important question, for while historians have much to say about the standardization of laboratory animals, they rarely consider the standardisation of the procedures performed upon them.[80]

As non-verbal subjects, animals left no authentic records. Consequently the 'patient's experience' of surgical practice can only be captured through records created by humans.[81] However in this respect, animals are little different from other patient groups studied by medical historians such as poor women and the mentally ill, and may be studied in the same way, through the analysis of surviving clinical records.[82] Coupled with the analysis of veterinary surgical texts and discussions, this would do more than illuminate the history of surgery and human-animal relations: by centring

the analysis on the animal surgical subject, it would also contribute to the burgeoning field of animal history by revealing the ways in which animals both shaped and were shaped by surgical practices.

To summarise: The development of dedicated histories of animal surgery is both necessary and important. It promises to add a new dimension to accounts of veterinary and experimental medicine, to enrich histories of animals and of human surgery, and to develop new connections between these domains. Tracing the circulation of ideas, practices, humans and animals between different surgical contexts would illuminate the circumstances under which surgery transcended the barriers of species and profession to reflect and reshape ideas of what it meant to be human or animal. Identifying the times and places in which these barriers held firm would prove equally revealing - of hierarchies between species and the ambiguities of human-animal relationships. Implicit in the investigation of such issues is the reconceptualization of surgery as a more-than-human phenomenon, an approach that provides a long overdue correction to the outdated anthropocentrism of existing surgical history.

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[1] Abigail Woods, "Animals and Disease", in *Routledge History of Disease*, ed. Mark Jackson, (London: Routledge, 2017, forthcoming).

[2] Most significantly, the special issue of *History and Philosophy of the Life Sciences* 31, no. 3-4 (2009).

[3] Andreas Holger-Maehler and Ulrich Tröhler, "Animal Experimentation from Antiquity to the End of the Eighteenth Century-Attitudes and Arguments," in *Vivisection in Historical Perspective*, ed. Nicholaas Rupke (London: Routledge, 1990), 14.

[4] Frederick Churchill, "Life Before Model Systems: General Zoology at August Weismann's Institute," *American Zoologist* 37 (1997), 260-68. The genealogy of the term 'model' merits further investigation.

[5] It is acknowledged that humans are also animals and that surgery was occasionally performed upon non-vertebrates such as flies, but they were not referred to as 'animals' at the time.

[6] Thomas Schlich, Eric Mykhalovskiy, and Melanie Rock, "Animals in Surgery – Surgery in Animals: Nature and Culture in Animal-Human Relationship and Modern Surgery," *History and Philosophy of the Life Sciences* 31 (2009): 321–54.

[7] Thomas Schlich, "Ein Netzwerk von Kontrolltechnologien: Eine Neue Perspektive auf die Entstehung der Modernen Chirurgie," *NTM Journal of the History of Science, Technology and Medicine* 16 (2008): 333-361, see 338.

[8] Descola posits this shared 'physicality' as fundamental to the 'naturalistic' ontology that he regards as characteristic of the Western view of animals. By contrast, the mind, soul or consciousness of animals is regarded as distinct to that of humans. P. Descola, *Par-delà Nature et Culture*, (Paris: Gallimard, 2005), 168-180.

[9] Schlich, Mykhalovskiy and Rock, "Animals in Surgery", 322-23.

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